

## N O T I C E

THIS DOCUMENT HAS BEEN REPRODUCED FROM  
MICROFICHE. ALTHOUGH IT IS RECOGNIZED THAT  
CERTAIN PORTIONS ARE ILLEGIBLE, IT IS BEING RELEASED  
IN THE INTEREST OF MAKING AVAILABLE AS MUCH  
INFORMATION AS POSSIBLE

---

# Chemical Research Projects Office: An Overview and Bibliography — 1975-1980

---

D. A. Kourtides, A. H. Heimbuch, and J.A. Parker

---

(NASA-TM-81227) CHEMICAL RESEARCH PROJECTS  
OFFICE: AN OVERVIEW AND BIBLIOGRAPHY,  
1975-1980 (NASA) 36 p HC A03/ME A01

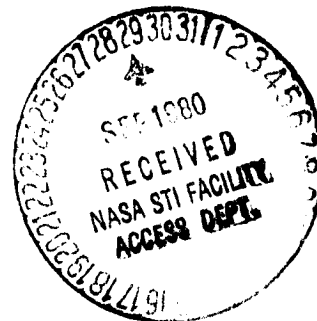
N80-31473

CSCL 57D

Unclass

G3/23 28637

August 1980



**NASA**  
National Aeronautics and  
Space Administration

---

# **Chemical Research Projects Office: An Overview and Bibliography — 1975-1980**

---

D. A. Kourtides, A.H. Heimbuch, and J.A. Parker  
Ames Research Center, Moffett Field, California



National Aeronautics and  
Space Administration

**Ames Research Center**  
Moffett Field, California 94035

## Table of Contents

Portrait	1
Accomplishments	3
Polymer Research Group	5
Aircraft Operating and Safety Group	6
Engineering Testing Group	7
Projects	8
Publications	11
Contracts and Grants	22
Presentations	27
Patents	31

PRECEDING PAGE BLANK NOT FILMED

CHEMICAL RESEARCH PROJECTS OFFICE: AN OVERVIEW  
AND BIBLIOGRAPHY—1975-1980

Portrait

The Chemical Research Projects Office (CRPO) conducts basic and applied research in the fields of polymer chemistry, computational chemistry, polymer physics and physical and organic chemistry. Materials developed and tested in the CRPO contribute to aircraft safety by decreasing the fire hazard and increasing the durability of tires, for example. Related industries may benefit from these products as well.

Since its founding, the CRPO has worked to identify the chemical research and technology required for solutions to problems of national urgency, synchronous with the aeronautic and space effort. At the same time, the strong technological base developed in the CRPO supports the domestic needs of the nation. CRPO scientists maintain and develop skills in the areas of polymer synthesis and characterization, the development and processing of polymeric materials composites, and the basic analytical chemistry and instrumentation needed to support CRPO activities.

Another purpose of the CRPO is to conduct interdisciplinary research on chemical problems, mainly in areas of macro-molecular science and fire research. New and improved materials systems and other fire control systems, such as high temperature foams, composites and fire extinguishing systems that are developed primarily for aerospace applications, can often be applied to national domestic problems.

The CRPO also acts as liaison with the engineering community and assures that relevant technology is made available to other NASA centers, agencies and industry. Experiments are run in the CRPO to insure the quality of information transferred. CRPO laboratories are equipped to handle bench-scale to full-scale tests. In order to demonstrate the improvements in performance obtained through the use of materials and fire control measures developed in the CRPO, scientists experiment with modified or retrofitted aircraft systems and subsystems in these facilities.

The scope of CRPO research encompasses transportation safety in human environments, space exploration and advanced aircraft progress, and technological utilization for civil applications.

In the area of transportation safety, CRPO scientists work on fire control and fire extinguishing methods in vehicles and structures. They conduct toxicity studies of fire-retardant materials, develop high performance aircraft tire and brake

materials, and develop high temperature elastomers for fuel tank sealants for advanced supersonic and conventional aircraft.

The CRPO furthers space exploration and advanced aircraft progress by developing advanced aerospace materials. Some of these materials stand up to environmental extremes, such as those used for entry thermal protection. Others are fire-resistant, functional nonmetallic materials for aircraft applications.

Technology utilization for civil applications is another aspect of CRPO research. As an example of this, CRPO scientists simulated the heating environment associated with liquid propane (LPG) fire by employing skills in combustion, heat transfer, and fluid mechanics. They applied this characterization to LPG railroad tank cars via fire test facility.

Additional civil applications include the following: applying information learned about aircraft crash-fire survivability to fire refuges for high rise dwellings; developing microanalytical chemical systems and applying chemical modeling to biochemical problems to build a morphine detector; applying knowledge of aircraft interior materials to rapid transit systems; and utilizing computer technology to map liquid natural gas spills in inland harbor areas.

## Accomplishments

Synthesization of new aromatic bismaleimides having high char yields.

Use of dynamic mechanical analysis to relate the degree of cure and mechanical properties of composite resin matrix systems as a function of temperature.

Continued validation of the theory relating the char forming properties with LOI, smoke and toxicity.

Computation of quantum chemical calculations have shown previously unknown vibrational potentials of the stilbazole molecules; also energy levels of 82-atom cluster trans-polyacetylene.

Development of synthesis specifications for pilot plant production of the epoxy of bisphenol fluorene and bisaminophenyl fluorene.

A beginning of the elucidation of polystyrylpyridine pyrolysis mechanisms leading to charring and crosslinking.

The mechanical and electrical properties of a carbon fiber have been controlled to a significant degree by the proper selection of thermal and gaseous environments used in the carbonization process.

It was shown that the T<sub>g</sub> (glass transition temperature), as determined by dynamic mechanical analysis, is a function of the degree-of-cure for a phenolic novolac resin.

It was shown that the epoxy resin of MY 720/DDS photo-oxidizes much faster than EPON 828/DDS.

Construction and distribution of laboratory scale thermal-impact test device to LARC, LERC, ARC (2), NWC, NSWC, AMMRC, U of M, NADC, and JPL.

Demonstration that physical properties of carbon fibers can be controlled by realistic processing variations.

Development of sub-scale test device for multi-axis loading and evaluation of composite materials.

Development of sub-scale simulator for in-flight fire testing of aircraft components (NASA/Navy, NASA-DOT).

Development of computer model for cost benefit analysis of new composite systems.

Development and verification of pool fire model for risk analysis of carbon fiber release hazard.

Discovery of uncatalyzed thermal cis-trans isomerization and new thermal cyclization processes in unsaturated polymers.

Spectroscopic characterization of microstructural changes produced in diene polymers during thermal and photo-sensitized oxidation.

Photo/thermal degradation of polyimide film of the Kapton type.

Development of a new aircraft tire retread formulation with improved heat build-up and heat blow-out properties.

Characterization of plasma-etched polyimide film for solar sail.

Development of an advanced sandwich panel system for use in aircraft interiors (e.g. Boeing 757, 767.).

Development of fire blocking layer concept for aircraft seats.

Identification of candidate film systems for aircraft interiors.



### Polymer Research Group

The activities of this group support aerospace and nonspace programs, and its objectives are specifically established for the purpose of providing a sound technology base.

Because most aircraft fires occur during accidents when fuel sprays out of the tanks, mixes with air, and ignites, chemists in polymer research are studying antimisting polymer additives for kerosene. Kerosene treated with the polymer additive comes out of the fuel tank in globs and strings, preventing the fuel from mixing readily with air, reducing the fire hazard.

Basic studies on new elastomers in polymer research are leading to safer and more efficient aircraft tires which wear longer, have improved traction and load bearing characteristics, and are resistant to blow-outs.

To discover how polymers work, chemists use computational chemistry for the prediction of new polymers, and for development of theoretical models for the structure and properties of polymer fibers.

Work in polymer physics includes experiments with the solid state conduction properties of polymers. One aim is to determine how and why electricity is conducted in carbon fibers. A practical application of this work could be improved space power systems.

Two areas of polymer physical chemistry under investigation concern prediction of the combined thermal/oxidative effects on high performance elastomers and the underlying chemistry of the polymer aging process. In particular, chemists want to discover those processes which involve interaction of fibers and resins. Hydrolytic and humidity damage to aircraft is also under study.

## Aircraft Operating Problems and Safety

This group formulates, processes and develops polymeric materials and composite systems as model and prototype specimens for chemical and engineering tests.

Polymers derived from both NASA aerospace technology and industry are used to develop films, coatings, composites, and laminates for a variety of purposes. Primarily, material systems are being developed which have greater fire resistance and thermal insulative properties as well as a significant decrease in the toxicity of the pyrolysis products.

Research on polymer composites by this group yielded a materials with the characteristics of both fracture toughness and fire resistivity. This high performance polymer composite will be used to make durable and fire resistant materials for aircraft components.

Other group research involves high temperature resistant elastomers for foams and aircraft sealants, and tests on organic metaloid polymers for heat shields.

### Engineering Testing Group

Fire safety tests on prototype materials and thermal protection systems in aircraft are designed and performed by the engineering testing group. Group scientists developed a full-scale fire test facility in which prototype structures are studied under well-defined conditions. An important feature of this facility is that impact and fire situations can be simulated there.

In addition, the group conducts fire tests on aircraft secondary structures such as lavatories, cargo bays, and furnishings. Comparisons are made of the results of toxicological tests on new materials and those currently in use.

Others projects include designing fuselage panels which are more fire resistant, using analytical models to predict potential fire environments, and testing dry chemical systems for fire quenching ability.

## Projects

### Aircraft Interior Materials Flammability

This program is directed towards enhancing post-crash fire survivability in aircraft by the application of advanced fire-resistant cabin materials. Elements of the program include the development of (a) decorative inks, films and adhesives for aircraft interior panels, (b) fire-resistant windows, (c) seat components and seat assemblies, (d) thermoplastic components, (e) modeling and analysis of fire configuration and (f) establishment of data bank for aircraft materials.

### High Performance Tires

Work is being done in this program to improve aircraft safety and efficiency through the use of advanced materials in aircraft tires. This involves the development and evaluation of new tread and/or carcass formulations which will yield commercial and military transport aircraft tires having improved wear resistance, traction, blowout resistance and load-bearing characteristics compared to state-of-the-art tires based on natural rubber (NR) and cis polybutadiene (CB). Amorphous vinyl polybutadiene (VB) was found in laboratory, track and flight tests to be a promising replacement for CB in tread stocks for Boeing 727 main landing gear tires. Since the VB rubber used to date (prepared by Ziegler-Natta polymerization) proved to be inconsistent in properties, new tread stocks are being compounded with NR and another VB (prepared by anionic polymerization) which is inherently capable of better uniformity and better properties than the Ziegler-Natta VB. Aircraft tires retreaded with the optimum NR/anionic VB formulation(s) are being evaluated in track and flight tests. Studies are being initiated on failure modes in aircraft tires and on risk assessment.

### Fuel Tank Sealants

Fuel tank sealants are being developed which offer improved service life under conditions encountered in advanced supersonic aircraft when compared to state-of-the-art materials. The specific objective is to obtain pilot plant quantities of char-

acterized and sealant materials for flight test evaluation. The goal are being accomplished through a series of steps as follows: Producing a fluoroether prepolymer in the 20 pound range; converting it to a gum stock containing an appropriate cross-linking; formulating the sealant elastomer into a material suited to a fillet seal application; and applying the fluoroether sealant to flight simulation studies and developing a performance specification from actual flight tests. Increasing the technology base by utilizing new fluoroether materials to modify polymeric systems such as composite resins and adhesives for expanded applications are other objectives of this project.

### Composite Material Modification

This project is performing research to provide tough, thermally stable and fire resistant polymers to serve as candidate materials for a variety of applications in the aerospace field. The main emphasis is to design polymers for use in primary and secondary composite structures, transparent films and windows, foams and adhesives. Objectives of the project include the development of (1) new matrix resins and (2) improved fibers which will be used for the preparation of (3) advanced composites for aircraft structures. The control of electrical conductivity in modified carbon fibers for use in composites is also being studied, with an extension of the study toward photovoltaic materials for solar energy systems.

Other research includes the development of better matrix resins for composites of high fracture toughness and the use of polymer grafts and copolymer blends. Polymers being investigated for resin matrix systems include modified polystyrylpyridine (PSP), fluorene-modified epoxies, phenolic novolac and resole, modified bismaleimides, and the aromatic polyether etherdetone (a tough thermoplastic). Polymers which are being considered for photovoltaic doped systems include polyacetylene and polyparaphenylene-sulfide. In addition, computational chemistry is being applied to large atomic cluster arrays as models for polymeric macro-molecules.

### Military Vulnerability Suppression

This project is studying state-of-the-art adhesives for composite materials. This work is funded by Joint Technical Coordinating Group for Aircraft Survivability. It is also studying smoldering combustion and coatings for composite materials. Other research

includes: (a) modeling the dispersion of fibers released from an airborne device; (b) developing and testing light weight thermal insulation/barrier for Navy ships structure; (c) modeling aircraft carrier deck fuel fires and experimentally verifying and upgrading the model to include wind conditions; and (d) evaluating the effects on the mechanical properties of composite materials due to thermal radiation exposure.

### Publications

1. D. A. Kourtides: "Performance Properties of Graphite Reinforced Composites with Advanced Resin Matrices." *Plastics Design and Processing*, January 1980.
2. D. A. Kourtides: "Processing and Flammability Characterization of Graphite Composites with Advanced Resin Matrices." *Proceedings of the Society of Plastics Engineers, ANTEC Meeting*, May 1980, New York, New York,
3. D. A. Kourtides: "Graphite Composites with Advanced Resin Matrices." *Proceedings of AIAA/ASCE/AHS 21st Structure, Structural Dynamics, and Materials Conference*, May 12-14, 1980, Seattle, Washington.
4. L. L. Fewell, F. Duskin, H. Spieth, E. Trabold, and J. A. Parker: "Release-Rate Calorimetry of Multilayered Materials for Aircraft Seats." *Proceedings of AIAA/ASME/AHS 21st Structures, Structural Dynamics, and Materials Conference*, May 12-14, 1980, Seattle, Washington.
5. M. A. Golub: "Photosensitized Oxidation of Unsaturated Polymers." *Pure Applied Chemistry*, 52, 305 (1980).
6. M. A. Golub and M. L. Rosenberg: "Photorearrangements of Hydrocarbon Polymers with Pendant Double Bonds." *Journal of Polymer Science, Polymer Chemistry Edition*, 18, (1980).
7. M. A. Golub: "Thermal Rearrangements of Polybutadienes with Different Vinyl Contents." *Polymer Preprints*, 21, (1980).
8. D. E. Cagliostro: "Modeling of Exposure to Carbon Monoxide in Fire." Submitted to *Journal of Combustion Toxicology*, August 1980.
9. D. E. Cagliostro: "Carbon Fiber Productional Low Temperatures from Polyacrylonitrile." Submitted to *Textile Research Journal*, 1980.
10. R. Ballard, D. E. Cagliostro, M. Gross, M. T. Hsu, and W. Winslow: "Radiant Panel Tests on an Epoxy/Carbon Fiber Composite." *NASA Technical Memorandum*, 1980, in print.
11. W. J. Gilwee and R. H. Fish: "A Small-Scale Test for Fiber Release from Carbon Composites." *NASA TM-81179*, February 1980.
12. W. J. Gilwee, J.A. Parker, and D. A. Kourtides: "Oxygen Index Tests of Thermosetting Resins." *Journal of Fire and Flammability*, January 1980.
13. N. R. Lerner: "Electrical Conductivity and ESR in Oxidatively Stabilized PAN Subjected to Elevated Temperatures." Submitted for publications in *Journal of Polymer Science, Polymer Physics Section*, 1980.

14. I. K. Varma, G. M. Fohlen, M. T. Hsu, and J. A. Parker: "The Mass Spectral Studies of some Bismaleimides." Submitted to Journal of Mass Spectroscopy, 1980.
15. J. Holloway and G. M. Fohlen: "The Use of 9,9 Bis-(4-aminophenyl) fluorenes as a Curing Agent for Epoxy Resins." Submitted to Journal of Polymer Science, 1980.
16. I. K. Varma, G. M. Fohlen, and J. A. Parker: "Addition Polyimides Based on Bis(m-aminophenyl)methyl phosphine Oxide." Submitted to Journal of Polymer Science, 1980.
17. L. L. Fewell, G. Tesoro, A. Monssa, and D. A. Kourtides: "Fire Resistant Materials for Aircraft Passenger Seat Construction." SAMPE Quarterly, April 1980.
18. L. L. Fewell, F. Duskin, H. Spieth, E. Trabold, and J. A. Parker: "Release-Rate Calorimetry of Multilayered Materials for Aircraft Seats." SAMPE Quarterly, April 1980.
19. R. W. Rosser and R. A. Korus: "Synthesis of Perfluoroalkylether Triazine Elastomers." Journal of Polymer Science, Polymer Letters Edition, 18, 135 (1980).
20. R. Ballard, D.E. Cagliostro, M. Gross, M. T. Hsu, and W. Winslow: "Some Pyrolytic/Toxicity Tests on Epoxy/Graphite Panels in a Radi Panel System." NASA TM-78618, October 1979.
21. M. A. Golub, M. L. Rosenberg, and R. V. Gemmer: "Singlet Oxygenation of 1,2-Poly(1,4-hexadiene)s." Journal of Polymer Science, Polymer Chemistry Edition, 17, 3751 (1979).
22. R. W. Rosser and R. A. Korus: "Synthesis of Perfluoroalkylether Oxadiaole Elastomers." Journal of Polymer Science, Polymer Letters Edition, 17, 635 (1979).
23. D. A. Kourtides and J. A. Parker: "Thermochemical Characterization of some Thermally Stable Thermoplastic and Thermoset Polymers." Journal of Polymer Engineering and Science, 19, 1, 24 (1979).
24. D. A. Kourtides and J. A. Parker: "Thermoset Resins for Fire Resistant Composites." Proceedings of the 37th Annual Technical Conference of the Society of Plastics Engineers, May 1979, New Orleans, Louisiana.
25. D. A. Kourtides, J. A. Parker, and W. J. Gilwee: "Thermal Response of Composite Panels." Journal of Polymer Engineering and Science, 19, 3, 226, (1979).
26. C. F. Hansen: "Viscosity and Thermal Conductivity of Model Jupiter Atmospheres." NASA TM-78556, 1979.
27. C. P. Schneider, R. J. Exberger, and C. F. Hansen: "Microwave Diagnostic for the Determination of Electron Temperature of a Low Density Shock-Heated Argon Plasma." NASA TM-78466, 1979.



28. S. C. Lin and E. M. Pearce: "Epoxy Resin II, The Preparation, Characterization and Curing of Epoxy Resins and their Copolymers." *Journal of Polymer Science, Polymer Chemistry Edition*, 17, 3095-3119 (1979).
29. S. C. Lin, J. Bulkin, and E. M. Pearce: "Epoxy Resin III. Applications of Fourier Transform IR to Degradation Studies of Epoxy Systems." *Journal of Polymer Science, Polymer Chemistry Edition*, 17, 3141-3148 (1979).
30. M. S. Lin: "Part I. Exploratory Synthesis of New Fire Safe Polymeric Materials; Part II. Thermal Degradation Study of Phenolphthalein Polycarbonate." Ph. D. Dissertation, Polytechnic Institute of New York, May 6, 1979.
31. C. P. Schneider, R. J. Exberger, and C. F. Hansen: "Microwave Diagnostic for the Determination of Electron Temperature of a Low Density Shock-Heated Argon Plasma." NASA TM-78466, 1979.
32. S. C. Lin and E. M. Pearce: "Epoxy Resins I. The Stability of Epoxy-Trimethoxyboroxine System." *Journal of Applied Polymer Science*, 23, 3355-3374 (1979).
33. A. C. Poshkus: "An Improved Synthesis of 2,4,8,10-Tetroxaspiro (5,5) undercane. (Pentarythritol Diformate)." *Journal of Heterocyclic Chemistry*, 16, 1075 (1979).
34. A. C. Poshkus: "An Improved Synthesis of 1,3:2, 4:5, 6-Trimethylenesorbitol and 1, 3:2, 4, 6-Trimethylenemannitol." *Journal of Organic Chemistry*, 44, 2794 (1979).
35. D. A. Kourtides: "Characterization of Graphite Composites with Advanced Resin Matrices." Submitted to the *Journal of Plastics Design and Processing*, 1979.
36. D. A. Kourtides and G. A. Johnson: "Conference on Fire Resistant Materials and Compilation of Presentations and Papers." NASA CP-2094, July 1979.
37. D. E. Cagliostro and D. C. Zemmer: "Modeling the Toxicity of Burning Polymethylmethacrylate." *Fire Technology*, May 1979.
38. R. W. Rosser: "Syntheses and Degradation of Fluorinated Heterocyclics IV Imidoamidoximes, 1,2,4-Oxadiazole Precursors." Submitted to the *Journal of Fluorine Chemistry*, 1979.
39. D. A. Kourtides and J. A. Parker: "Advanced Thermoset Resins for Fire Resistant Composites." Proceedings of the 11th National SAMPE Technical Conference, November 1979. Boston, Massachusetts.
40. R. W. Rosser: "Gel Permeation Chromatography of Fluoroether Polymers." *Analytical Chemistry*, 50, 249 (1978).

41. M. A. Golub, M. L. Rosenberg, and R. V. Gemmer: "Spectroscopic Study of Photosensitized Oxidation of Polyisoprene." *Polymer Preprints*, 17, 699-705 (1976); *Rubber Chemistry Technology*, 50, 704-713 (1977); *In Applications of Polymer Spectroscopy.* F. G. Brame, Jr., Ed., Academic Press, New York, 1978.
42. G. D. Mendenhall, R. A. Nathan, and M. A. Golub: "Chemiluminescence Study of the Autoxidation of cis-1,4-Polyisoprene." *Polymer Preprints*, 17, 726-731 (1976); *In Applications of Polymer Spectroscopy.* F. G. Brame, Jr., Ed., Academic Press, New York, 1978.
43. C. J. Hilado, J. E. Schneider, J. A. Parker, and D. A. Kourtidis: "ALC 50 Values for some Polymeric Materials." *Journal of Fire and Flammability*, 5, (1978).
44. D. A. Kourtidis and J. A. Parker: "Flammability and Thermochemical Properties of Some Thermoplastics and Thermoset Polymers-A Review." *Journal of Polymer Plastics Technology and Engineering*, 10, 1978.
45. D. A. Kourtidis, W. J. Gilwee, and J. A. Parker: "Thermal response of Composite Panels." *Proceedings of the 36th Annual Technical Conference, Society of Plastics Engineers*, April 1978, Washington, D. C.
46. D. A. Kourtidis and J. A. Parker: "Relative Fire Resistance of Some Thermoplastic Polymers." *Journal of Plastics Design and Processing*, April 1978.
47. D. A. Kourtidis, W. J. Gilwee, and J. A. Parker: "Oxygen Index Tests for Some Polymers." *Proceedings of the 36th Annual Technical Conference, Society of Plastics Engineers*, April 1978, Washington, D. C.
48. D. A. Kourtidis and J. A. Parker: "Characterization of Flammability Properties of Some Thermoplastic and Thermoset Resins." *Proceedings of the 23rd National SAMPE Symposium*, May 1978, Anaheim, California.
49. D. A. Kourtidis: "Conference on Fire Resistant Materials (FIREMEN)--A Compilation of Presentations and Papers." NASA TM-78523, October 1978.
50. D. A. Kourtidis: "Handbook on Thermochemical Characterization of Polymers." Marcel Dekker, Inc. (In preparation).
51. D. A. Kourtidis: "Fire Resistant Thermoset and Thermoplastic Resins for Aircraft Interiors." *Proceedings of the Fire Retardant Chemicals Association Meeting*, October 1978, San Francisco, California.
52. D. A. Kourtidis: "Thermochemical and Flammability Properties of Some Thermoplastic and Thermoset Polymers--A Review." *Journal of Polymer Plastics Technology Engineering*, 11, 2, 159-198 (1978).
53. S. L. Hartford, S. Subramanian, J. A. Parker, and G. M. Fohlen: "Synthesis of N-Substituted Bis-itaconimide Monomers for use as Thermosetting, Polyimide Resins." *Journal of Applied Polymer Science*, 22, 137 (1978).

54. D. E. Cagliostro: "Modeling Aerosol Losses and Clothing Effects in Fires." *Journal of Fire and Flammability*, 9, (1978).
55. L. L. Fewell: "Flash-Fire Propensity and Heat Release Rate Studies of Improved Fire Resistant Materials." NASA TM-78550, December 1978.
56. M. L. Halberstadt, S. K. Rhee, and J. A. Mansfield: "Effects of Potassium Titanate Fiber on the Wear of Automotive Brake Linings," *Journal of Wear*, 46, 109-126 (1978).
57. L. L. Fewell, E. L. Trabole, and H. H. Spieth: "Fire Resistivity and Toxicity Studies of Candidate Aircraft Passenger Seat Materials." *Journal of Fire and Flammability*, 9, (1978).
58. D. A. Kourtides and J. A. Parker: "Thermochemical Characterization of Some Thermally Stable Thermoplastic and Thermoset Polymers." *Journal of Polymer Engineering and Science*, January 1978.
59. D. A. Kourtides and J. A. Parker: "Flammability Properties of Thermoplastic and Thermoset Resins." *Journal of SAMPE Quarterly*, April 1978.
60. W. J. Gilwee, C. J. Hilado, and D. A. Kourtides: "Relative Toxicity of the Pyrolysis Products from Some Thermoplastic and Thermoset Polymers." *Journal of Polymer Engineering and Science*, June 1978.
61. M. A. Golub: Book Review: "Developments in Polymer Degradation-1." N. Grassie, Ed., *Rubber Chemistry Technology*, 1978.
62. J. A. Parker and D. A. Kourtides: "Assessment of Relative Flammability and Thermochemical Properties of Some Thermoplastic Materials." *Journal of Polymer Engineering and Science*, July 1978.
63. R. V. Gemmer and M. A. Golub: "Spectroscopic Study of Thermal Oxidation of cis-1,4-Polybutadiene." *Polymer Preprints*, 17, 676-681 (1979); and in "Applications of Polymer Spectroscopy." E. G. Brame, Jr., Ed., Academic Press, New York, 1978.
64. A. H. Heimbuch, J. A. Parker, A. Schindler, and H. G. Olf: "Low-Gravity Synthesis of Polymers with Controlled Molecular Configuration." *Progress in Astronautics and Aeronautics*, 52, (1977); *Materials Science in Space with Application to Space Processing*, AIAA, New York.
65. N. R. Lerner: "Thermochemical Characterization of Polymers for Improved Fire Safety." *Journal of Combustion Toxicology*, May 1977.
66. N. R. Lerner: "Isothermal Degradation of Poly-2, 2'-(m-phenylene)- 5,5'-Bibenzimidazole." *Journal of Polymer Science, Polymer Edition*, May 1977.
67. C. Hilado, D. A. Kourtides, L. L. Fewell, and J. A. Parker: "Relative Toxicity of Pyrolysis Products of Some Aircraft Seat Materials." *Journal of Combustion Toxicology*, February 1977.

68. J. A. Mansfield: "The Development of Passive Fire Protection Systems for Ships." In-house report.
69. M. A. Golub: "Thermal Cyclization of 1,2-Poly(trans-1,3-pentadiene): An Intramolecular Reaction." *Journal of Polymer Science, Polymer Letters Edition*, 15, 369-376 (1977).
70. M. A. Golub, D. B. Parkinson, J. I. Cunneen, and W. F. Watson: "Cis-trans Isomerization of Polybutadienes and Polyisoprenes." *Macromolecular Synthese, Coll, Vol. I*, J. A. Moore, Ed., Wiley, 1977.
71. A. Buchler and D. E. Cagliostro: "Military Fighter Aircraft Survivability of Nonmetallic Materials Identification and Fire Threat." NASA TM-73226, June 1977.
72. M. T. Hsu: "Analytical Methods for Toxic Gases from Thermal Degradation of Polymers." *Journal of Combustion Toxicology*, 4, 293 (1977).
73. K. J. L. Paciorek, R. H. Kratzer, J. Kaufman, J. H. Nakahara, R. W. Rosser, and J. A. Parker: "Synthesis and Degradations of Fluorinated Heterocyclics II. Perfluoroalkyl and Perfluoroalkylether-1,2,4-Oxadiazoles." *Journal of Fluorine Chemistry*, 10, 119-129 (1977).
74. K. J. L. Paciorek, J. H. Nakahara, R. H. Kratzer, and R. W. Rosser: "Mass Spectra of some Perfluoroalkylether Substituted 1,2,4-Oxadiazoles." *Organic Mass Spectrometry*, 12, 2, 71-74 (1977).
75. K. J. L. Paciorek, J. Kaufman, J. H. Nakahara, T. I. Ito, R. H. Kratzer, R. W. Rosser, and J. A. Parker: "Synthesis and Degradations of Fluorinated Heterocyclics III. Perfluoroalkyl and Perfluoroalkylether-1,3,4-Oxadiazoles." *Journal of Fluorine Chemistry*, 10, 277-288 (1977).
76. W. D. Kray and R. W. Rosser: "Synthesis of Multifunctional Triaryl-fluoroethanes, Condensation of Fluoro Ketones." *Journal of Organic Chemistry*, 42, 1186 (1977).
77. C. J. Hilado, J. A. Foriano, K. L. Kosola, J. A. Parker, and D. A. Kourtides. "Toxicity of Pyrolysis Gases from Synthetic Polymers." NASA TM-78462, December 1977.
78. D. A. Kourtides, W. J. Gilwee, and J. A. Parker: "Thermochemical Characterization of Some Thermally Stable Thermoplastic and Thermoset Polymers." *Proceedings of the Regional Technical Conference, Society of Plastics Engineers*, October 1977, Hartford, Connecticut.
79. D. E. Cagliostro: "The Interaction of Compartment Interior Materials with Fuel Fire." NASA TMX-73222, March 1977.
80. D. A. Kourtides, C. J. Hilado, C. J. Casey, and J. A. Parker: "Toxicity of Materials in Fire Situations." NASA TM-78462, 1977.

81. D. A. Kourtides and J. A. Parker: "Assessment of Relative Flammability and Some Thermoplastic Materials." Proceedings of the 35th Annual Technical Conference, Society of Plastics Engineers, April 1977, Montreal, Canada.
82. D. A. Kourtides, J. A. Parker, and C. J. Hilado: "Thermoplastic Polymers for Improved Fire Safety." Proceedings of the Conference on Polymeric Materials and their Use in Transportation, The Department of Transportation, Polytechnic Institute, April 1977, New York, New York.
83. C. J. Hilado, G. J. Barnes, J. A. Parker, and D. A. Kourtides: "The Use of the High Flux Furnace in the Smoke Chamber to Measure Ignitability and Smoke Evaluation of Composite Panels." Journal of Fire and Flammability, 8, 3 (1977).
84. C. J. Hilado, H. J. Cumming, J. A. Parker, and D. A. Kourtides: "Systems for Animal Exposure in Full-Scale Fire Tests." Journal of Combustion Toxicology, 4, 2, 101-113 (1977).
85. W. H. Marcussen, A. Furst, J. A. Parker, L. L. Fewell, and D. A. Kourtides: "Relative Toxicity of Pyrolysis Products of Some Aircraft Seat Materials." Journal of Combustion Toxicology, 4, 1, 16-20 (1977).
86. C. L. Slattengren, J. A. Parker, and D. A. Kourtides: "Relative Toxicity of Pyrolysis Products of Some Polyurethane and Polychloroprene Foams." Journal of Combustion Toxicology, February 1977.
87. D. A. Kourtides and J. A. Parker: "Flammability Characteristics of Some Thermoplastic Polymers." Proceedings of the 4th International Symposium on Flammability and Fire Retardants, May 1977, Washington, D. C.
88. C. J. Hilado, N. V. Huttlinger, B. A. O'Neill, J. A. Parker, and D. A. Kourtides: "Toxicity of Pyrolysis Gases from Wood." NASA TM-78463, December 1977.
89. C. J. Hilado, H. J. Cumming, J. A. Parker, and D. A. Kourtides: "A Bibliography of Published Information Relevant to Fire Toxicity." NASA TM-78431, July 1977.
90. C. J. Hilado, K. L. Kosola, A. N. Solis, J. A. Parker, and D. A. Kourtides: "Toxicity of Pyrolysis Gases from Elastomers." NASA TM 78461, December 1977.
91. D. A. Kourtides, J. A. Parker, and C. J. Hilado: "Thermochemical Characterization of Some Thermoplastic Polymers." Journal of Fire and Flammability, January 1977.
92. D. E. Cagliostro and J. A. Parker: "Dynamic Modeling of Thermal and Gas Toxicity in Fires." Proceedings of the National Symposium on Fire Safety Aspects of Polymeric Materials, June 1977, Washington, D. C.
93. D. A. Kourtides, J. A. Parker, and R. W. Bricker: "Materials Research for Aircraft Fire Safety." NASA SP-416, October 1976.

94. D. A. Kourtidis: "Fire-Resistant Materials for Aircraft." Proceedings of the American Institute of Aeronautics and Astronautics Meeting, January 1976, Atlanta, Georgia.
95. D. A. Kourtidis, J. A. Parker, H. A. Leon, R. B. Williamson, H. Hasegawa, F. Fisher, R. Draemel, W. H. Marcussen, and C. J. Hilado: "Fire Containment Tests of Aircraft Interior Panels." Proceedings of the First International Conference on Fire Safety, January 1976, University of San Francisco, San Francisco, California.
96. W. H. Marcussen, C. J. Hilado, A. Furst, H. A. Leon, J. A. Parker, J. C. Rutte, J. M. Cummins, and D. A. Kourtidis: "Apparatus and Methodology for Fire Gas Characterization by Means of Animal Exposure." Journal of Combustion Toxicology, February 1976.
97. D. A. Kourtidis, J. A. Parker, H. A. Leon, R. B. Williamson, H. Hasegawa, F. Fisher, R. Draemel, W. H. Marcussen, and C. J. Hilado: "Fire Containment Tests of Aircraft Interior Panels." Journal of Fire and Flammability, April 1976.
98. W. J. Gilwee, J. A. Parker, and D. A. Kourtidis: "Fire Resistant Low Density Composites." Proceedings of the 1976 National Technical Conference, Society of Plastics Engineers, October 1976, Cleveland, Ohio.
99. D. A. Kourtidis, J. A. Parker, and C. J. Hilado: "Thermoplastic Polymers for Improved Fire Safety." NASA TM-73185, November 1976.
100. C. J. Hilado, K. Y. Smouse, J. A. Parker, and D. A. Kourtidis: "The Effect of Temperature and Air Flow on the Relative Toxicity of Polymeric Materials by the USF/NAS Toxicity Screening Test Method." Journal of Combustion Toxicology, August 1976.
101. W. H. Marcussen, A. Furst, J. A. Parker, and D. A. Kourtidis: "Apparent Lethal Concentrations of Pyrolysis Products of Some Synthetic Polymers." Journal of Combustion Toxicology, November 1976.
102. W. J. Gilwee, J. A. Parker, D. A. Kourtidis, and C. J. Hilado: "Fire Resistant Low Density Composites." Proceedings of the 1976 National Technical Conference, Society of Plastics Engineers, October 1976, Cleveland, Ohio.
103. L. L. Fewell, R. Rosser, D. A. Kourtidis, and J. A. Parker: "Conference on the Development of Fire Resistant Aircraft Passenger Seats." NASA TM-73144, August 1976.
104. C. J. Hilado, L. A. LaBossiere, H. A. Leon, J. A. Parker, M. T. Hsu, and D. A. Kourtidis: "The Sensitivity of Relative Toxicity Rankings by the USF/NASA Test Methods to Some Test Variables." Journal of Combustion Toxicology, August 1976.
105. R. L. Altman: "Evaluation of Dry Chemical Fire Extinguishants." Archiwum Termodynamiki i Spalania, 7, 557-562 (1976).

106. D. A. Kourtides, J. A. Parker, C. J. Hilado, L. A. LaBossiere, and M. T. Hsu: "A Composite System Approach to Aircraft Cabin Fire Safety." Proceedings of the National Fire Prevention Association, September 1976, Geneva, Switzerland.
107. T. J. Yager, J. L. McCarty, S. R. Riccitiello, and M. A. Golub: "Developments in New Aircraft Tire Tread Materials." In "Aircraft Safety and Operating Problems." NASA SP-416. 1976.
108. J. A. Mansfield, M. L. Halberstadt, S. R. Riccitiello, and S. K. Rhee: "An Improved Automotive Brake Lining Using Fibrous Potassium Titanate." NASA TN D-8363, August 1976.
109. L. L. Fewell: "Analysis of Thermal Reaction Products of Para Polyphenylene by Combined Gas Chromatography-Mass Spectrometry." Journal of Chromatographic Science, December 1976.
110. D. A. Kourtides, J. A. Parker, C. J. Hilado, L. A. LaBossiere, and M. T. Hsu: "A Composite System Approach to Aircraft Cabin Fire Safety." NASA TM-73126, April 1976.
111. C. J. Hilado, J. A. Parker, and D. A. Kourtides: "A Study of the Toxicology of Pyrolysis Gases from Synthetic Polymers." Journal of Combustion Toxicology, May 1976.
112. D. A. Kourtides, J. A. Parker, W. J. Gilwee, N. R. Lerner, C. J. Hilado, L. A. LaBossiere, and M. T. Hsu: "Flammability Characteristics of Aircraft Interior Composites." Journal of Fire and Flammability, July 1976.
113. C. J. Hilado, C. L. Slattengren, A. Furst, J. A. Parker, and D. A. Kourtides: "Relative Toxicity of Pyrolysis Products of Some Synthetic Polymers." Journal of Combustion Toxicology, August 1976.
114. C. J. Hilado, G. L. Saxton, J. A. Parker, W. J. Gilwee, and D. A. Kourtides: "Relative Toxicology of Pyrolysis Products of Some Cellular Polymers." Journal of Combustion Toxicology, August 1976.
115. D. A. Kourtides, J. A. Parker, C. J. Hilado, R. A. Anderson, E. Tustin, D. E. Arnold, J. A. Gaume, A. T. Binding, and J. A. Mikeska: "Fire Safety Evaluation of Aircraft Lavatory and Cargo Compartments." Journal of Fire and Flammability, January 1976.
116. D. A. Kourtides, J. A. Parker, H. A. Leon, R. B. Williamson, H. Hasegawa, F. Fisher, R. Draemel, W. H. Marcussen, and C. J. Hilado: "Fire Containment Tests of Aircraft Interior Panels." NASA TM-73090, 1976.
117. D. A. Kourtides, J. A. Parker, W. J. Gilwee, N. R. Lerner, C. J. Hilado, L. A. LaBossiere, and M. T. Hsu: "A Composite System Approach to Aircraft Fire Safety." NASA TMX-73126, April 1976.
118. R. W. Rosser: "Conference on Development of Fire-Resistant Passenger Seats." NASA TMX-73144, August 1976.

119. W. H. Marcussen, A. Furst, H. A. Leon, J. A. Parker, D. A. Kourtides, J. C. Butte, and J. M. Cummins: "Apparatus and Methodology for Fire Gas Characterization by Means of Animal Exposure." Proceedings of the International Conference on Fire Safety, January 1976, University of San Francisco, San Francisco, California.
120. W. Young, J. A. Parker, and D. A. Kourtides: "A Study of the Toxicology of Pyrolysis Gases from Synthetic Polymers." Proceedings of International Conference on Fire Safety, January 1976, University of San Francisco, San Francisco, California.
121. D. A. Kourtides, J. A. Parker, H. A. Leon, R. B. Williamson, H. Hasegawa, F. Fisher, R. Draemel, and W. H. Marcussen: "Fire Containment Tests of Aircraft Interior Panels." Proceedings of the International Conference on Fire Safety, January 1976, University of San Francisco, San Francisco, California.
122. R. W. Rosser and J. A. Parker: "Advanced Supersonic Technology Fuel Tank Sealants." Proceedings of the SCAR Conference, November 9-12, 1976, NASA CP-001,
123. D. E. Cagliostro and E. L. Winkler: "Methanator Fuel Conversion." ATM Environment, 9, 239-252 (1975).
124. D. E. Cagliostro, S. R. Riccitiello, K. Clark, and A. Shimizu: "Modeling of Intumescent Coatings." Journal of Fire and Flammability, April 1975.
125. R. W. Rosser and J. A. Parker: "Polyperfluoroalkylene Ethers as High Temperature Sealants." American Chemical Society Symposium Series #6, "Polyethers." 1975.
126. R. J DePasquale, C. D. Padgett, and R. W. Rosser: "Highly Fluorinated Acetylenes: Preparation and Some Cyclization Reactions." Journal of Organic Chemistry, 40, 6, 810-811 (1975).
127. K. L. Paciorek, R. H. Kratzer, J. Kaufman, R. W. Rosser: "Syntheses and Degradations of Fluorinated Heterocyclics." Journal of Fluorine Chemistry, 6, 241-258 (1975).
128. T. Dyble, S. R. Riccitiello, and D. E. Cagliostro: "Laser Hardened Transparent Polymers." Proceedings of the 1975 DOD Laser Effects/Hardening Conference, Vol. IV, Laser Hardening, December 1975 (classified).
129. M. A. Golub, M. T. Hsu, and L. A. Wilson: "Nuclear Magnetic Resonance Study of Thermal Oxidation of Polyisoprene." Rubber Chemistry Technology, 48, (1975).
130. J. A. Mansfield, S. R. Riccitiello, and L. L. Fewell: "An Effective and Practical Fire-Protection System." Journal of Fire and Flammability, October 1975.
131. J. A. Mansfield: "Railroad Tank Car Fire Program." DOT-NASA 1-8, February 1975.



132. D. A. Kourtides and J. A. Parker: "Effect of Processing Variables on the Thermo Physical Properties of Polybenzimidazole Foams." *Journal of Polymer Engineering Science*, 15, 6, 415 (1975).
133. D. A. Kourtides, J. A. Parker, and W. J. Gilwee: "Thermochemical Characterization of Aircraft Interior Panel Materials." *Journal of Fire and Flammability*, July 1975.
134. J. A. Parker, R. H. Fish, and D. A. Kourtides: "Fire Dynamics of Modern Aircraft from a Materials Point of View." *Journal of Fire and Flammability*, October 1975.
135. S. Schwartz, R. H. Fish, and D. A. Kourtides: "Fabrication of Fire-Resistant Transparencies." *Proceedings of the USAF-AFML Conference on Transparent Aircraft Enclosures*, September 1975, Atlanta, Georgia, AFML-TR-75.
136. D. A. Kourtides, J. A. Parker, C. J. Hilado, R. A. Anderson, E. Tustin, D. E. Arnold, J. G. Gaume, A. T. Binding, and J. L. Mikeska: "Fire Safety Evaluation of Aircraft Lavatory and Cargo Compartments." NASA TM-62471, August 1975.
137. R. W. Rosser: "Syntheses and Degradation of Fluorinated Heterocyclics." *Journal of Fluorine Chemistry*, 6, 241-258 (1975).
138. R. W. Rosser: "Highly Fluorinated Acetylenes: Preparation and Some Cyclization Reactions." *Journal of Organic Chemistry*, 40, 6, 810 (1975).
139. D. A. Kourtides, J. A. Parker, R. H. Fish, and W. J. Gilwee: "Fire Dynamics of Modern Aircraft from a Materials Point of View." *Proceedings of the AGARD Propulsion and Energetics Panel*, April 1975, Rome, Italy.

### Contracts and Grants

1. "Formulation and Characterization of Epoxy Resin Copolymer for Graphite Composites," Lockheed Missiles and Space Company, NAS2-10130.
2. "Char Resistance of Selected Phenolic Cured Epoxides," Lockheed Missiles and Space Company, NAS2-10207.
3. "Evaluation of 90% Vinyl Polybutadiene Elastomer from the Institut Francais du Petrole in an Aircraft Tire Tread Compound," Thompson Aircraft Tire Company, NAS2-10155.
4. "Composite Materials Comparative Cost Model," ECON, Inc., NAS2-9898.
5. "Carbon Fiber Modification," SRI International, NAS2-10090.
6. "Development and Testing of Aircraft Lavatory Compartments," Boeing Company, NAS2-8700.
7. "Development of Fire Resistant Screen Printing Inks," Boeing Company, NAS2-9864.
8. "Development and Fabrication of Aircraft Interior Fire Resistant Composite Panels," Boeing Company, NAS2-10004.
9. "Laboratory Data System," Digital Equipment Corporation, A-61613B.
10. "Thermal Analysis System," Dupont, A-72333B, A72334B.
11. "Study of Materials Performance Model for Aircraft Interiors," ECON, Inc., NAS2-10515.
12. "Fabrication of Graphite Composites," Hitco, NAS2-10301.
13. "Studies on New Perfluoroether Elastomer Fuel Tank Sealants," Hughes Aircraft Company, NAS2-10334.
14. "Thermochemical Tests on Resins," Lockheed Missiles and Space Company, NAS2-10207.
15. "Study to Develop Improved Fire Resistant Aircraft Seat Materials," McDonnell-Douglas Corporation, NAS2-9337.
16. "Study of Aircraft Crashworthiness for Fire Protection," McDonnell-Douglas Corporation, NAS2-10583.
17. "Spectrometer," Nicolet Instrument Corporation, A-70820B.
18. "Study/Analytical Prediction of Atmospheric Plumes and Particle Dispersal by Large Open Fires," Science Applications, Inc., NAS2-10039.

19. "Upgrading of Mathematical Fire Model," Science Applications, Inc., NAS2-10327.
20. "Fire Testing of NASA Samples," Scientific Service, Inc., NAS2-9945.
21. "Development of Graphite Polystyryl Pyridene (PSP) Structural Composites," Societe Nationale Des Pourdes, NASW-3251.
22. "Fire Test Methodology for Aerospace Materials," Southwest Research Institute, NAS-10140.
23. "Assess Burning of Aircraft Interior/Seat," Southwest Research Institute, NAS2-10148.
24. "Development and Fabrication of Bismaleimide-Graphite Composites," Technochemie GMBH Verfahrenst, NASW-3207.
25. "Synthesis of 8-Ether-Diacid Fluoride," Technochemie GMBH Verfahrenst, NASW-3239.
26. "Study of Crosslinking and Degradation Mechanisms in Sealant Polymer Candidates," Ultrasystems, Inc., NAS2-9779.
27. "Firing Testing of Graphite/Epoxy Composite Materials," U. S. Naval Sea Systems Command, A-57061B.
28. "Laminating Press for Printed Circuits," Wabash Metal Products Company, Inc., NAS2-10434.
29. "High Polymers Based on Phosphazene and Other Inorganic Systems," Pennsylvania State University, NSG-2364.
30. "Exploratory Synthesis of New Fire Safe Polymeric Materials," Polytechnic Institute, New York, NSG-2147.
31. "An Investigation of Toxic Hazards from Burning Materials in Controlled Fires," San Jose State University, NCC2-00004.
32. "Study of Optimum Insulation Configurations and Materials," San Jose State University, NCC2-0026.
33. "Characterization and Degradation Studies on Aromaticpolyimides," San Jose State University, NCC2-0028.
34. "Heat Release Studies for Aircraft Materials," San Jose State University, NCC2-0056.
35. "New Elastomers for Improved Aircraft Tires," San Jose State University, NCC2-0057.
36. "Study of Processing Parameters for Non-Metallic Composites," San Jose State University, NCC2-00065.

37. "Study of the Physical Properties of Composites," San Jose State University, NCC2-0080.
38. "Synthesis Characterization and Formulation of Perfluorocarbon Ether Elastomers," San Jose State University, NCC2-00081.
39. "Study of Characterization and Formulation of Fluorocarbon Ether Elastomers," San Jose State University, NSG-2186.
40. "Fiber Reinforced Polymeric Materials," San Jose State University, NSG-2332.
41. "Graphite-Epoxy Composite Protective Coatings," San Jose State University, NSG-2371.
42. "Influence of Fluid Rheology and Air Resistance on Behavior of Liquid Jets and Drops," University of California at Berkeley, NCA2-OR050001.
43. "Optimal Additives to Produce Anti-misting Fuels," University of California at Berkeley, NCA-OR050905.
44. "Study of Conductivity in Modified Graphite," University of California at Davis, NAS2-10258.
45. "Improvement in Mechanical Properties of Low Conductivity Carbon Fibers," University of California at Davis, NCC2-00020.
46. "A Study of Dry-Chemical Fire-Extinguishing Mechanisms," University of California at Los Angeles, NCA2-OR390903.
47. "High Deformation-Rate Extensional Rheology of Polymeric Anti-misting Additives," University of California at San Diego, NCA2-OR658001.
48. "Perfluorether Triazine Elastomers," University of Idaho, NSG-2367.
49. "Crash-Impact Fire of Fiber Reinforced Composites," University of Michigan at Ann Arbor, NSG-2333.
50. "Development of Theoretical Models for Graphite-Like Atomic Structures," University of Pennsylvania, NAS2-10070.
51. "Manufacture of DPFC-IMS Polymer in the 5kg Range and Study," University of Utah, NAS2-10064.
52. "Full-Scale Heat Release Studies of Aircraft Seats," Southwest Research Institute, NAS2-10148.
53. "Crosslinking and Degradations Mechanisms in Sealant Polymer Candidates," Ultrasystems, Inc., NAS2-9779.
54. "Synthetic Fabric Materials," Stanford University, NSG-2346.

55. "Environmental Stability of Composite Resin Matrices," San Jose State University, NSG-2353.
56. "Interstitial Encapsulation of Solid Inorganic Halons: An Investigation of the Synthesis and Characterization of Thermally Activated Flame Quenching and Suppressing Agents," San Jose State University, NCA2-OR675-807.
57. "Exploratory Synthesis of New Fire Safe Materials," Polytechnic Institute of New York, NSG-2147.
58. "Phosphazene-Skeletal Ring Polymers," Pennsylvania State University, NSG-2364.
59. "Characterization and Degradation Studies on Aromatic Polyimides, Polyesters, and Composite Resins," NSC-2274.
60. "Preparation of Linear Hydroxy Substituted Polyphosphazenes," Ultrasonics, Inc., NAS2-8469.
61. "Fire Safe Materials for Use in Aircraft Interior Panels," San Jose State University, NSG-2209.
62. "Development and Testing of Dry Chemicals in Advanced Extinguishing Systems," San Jose State University, NCA2-OR675-706.
63. "Inorganic Crystal Clathrates: Development and Modelling of a New Concept in Fire Control Involving Inorganic Micro-encapsulation and Thermally Controlled Release of Extinguishant Agents."
64. "The Stability of New Transparent Polymeric Material, The Epoxy-Trimethoxyboroxine Systems," Brooklyn Polytechnic Institute, NSG-2182.
65. "Crosslinking and Degradation Mechanisms in Model Sealant Candidates," Ultrasonics, Inc., NAS2-7981.
66. "Additional Crosslinking and Compounding of Heterocyclic Polyperfluoroalkylethers," SRI International, NAS2-8103.
67. "Study to Develop Improved Fire-Resistant Materials for Aircraft Passenger Seats," McDonnell-Douglas Aircraft Company, NAS2-9337.
68. "Crosslinking Study of Heterocyclic Perfluorinated Polyethers," Stanford Research Institute, NAS2-8103.
69. "Spectroscopic Study of Oxidation of Unsaturated Elastomers," San Jose State University, NSG-2111.
70. "Design of Ships Passive Fire Protection Systems: Structural Engineering Design," San Jose State University, NSG-2167.

71. "Design and Construction of a Test Furnace," San Jose State University, NCA-OR675-616.
72. "Preparation of Thermally Stable Dry Chemicals," San Jose State University, NSG-2223.
73. "Characterization and Formulation of Fluorocarbon Ether Elastomers," San Jose State University, NSG-2186.
74. "A Study on the Synthesis of Heterocyclic-Block-Perfluorinated Polyethers," SRI International, NAS2-8103.
75. "Foam Composite Structures," Delano, NASA CR-137834.
76. "Chemiluminescence Study of Aircraft Tire Rubber Thermal Degradation," Battelle-Columbus, NAS2-8195.
77. "Fabrication and Test of Experimental Automotive Friction Materials," Bendix Research Laboratories.
78. "Chemistry of Fire Extinguishant Materials Suitable for Aircraft Engine Nacelle Fire Control," San Jose State University, NCA2-OR675-618.
79. "Study of Thermal Stability and Degradation of Fire Resistant Candidate Polymers for Aircraft Interiors," NASA ch-148567.
80. "Friction and Abrasion of Aircraft Tire Tread Materials," University of Akron, NSG-2061.
81. "Inhibition of Hydrogen Cyanide (HCN) Evolution by Copper from Linear Polyurethane," NSG-2059.
82. "Chemistry of Fire Extinguishment Materials Suitable for Aircraft Engine Fire Control," San Jose State University, NCA2-OR675-618.
83. "Fabrication and Operation of a Fuel Tank Sealant Exposure Apparatus," Boeing Company, NAS2-7341.
84. "Synthesis of Perfluorinated Polyethers," PCR, Inc., NAS2-8156.
85. "Fire Suppression and Control Systems for Aircraft Survivability," San Jose State University, NCA2-OR675-505.
86. "Fire Suppression and Control Systems for Aircraft Survivability," San Jose State University, NCA2-OR675-601.

### Presentations

1. D. A. Kourtides and J. A. Parker: "Thermophysical and Flammability Characterization of Phosphorylated Epoxy Adhesives." Presented at the Adhesives for Industry Conference, El Segundo, California, June 1980.
2. D. E. Cagliostro, D. S. Varma, and H. L. Needles: "The Benzoic Acid Initiated Degradation of Polyacrylonitrile Fibers." To be presented at the ACS Meeting, San Francisco, California, August 1980.
3. R. Ballard, D. E. Cagliostro, M. Gross, M. T. Hsu, and W. Winslow: "Radiant Panel Tests on an Epoxy/Carbon Fiber Composite." Presented at the Naval Postgraduate School, Monterey, California, 1980.
4. W. J. Gilwee and J. Arajan: "Advanced Resin Systems for Graphite Epoxy Composites." Presented at the National Symposium on Polymers in the Service of Man, American Chemical Society, Washington, D. C., June 9-11, 1980.
5. C. F. Hansen and J. A. Parker: "Carbon Fiber Technology." Presented at the ACS Symposium on Polymers in the Service of Man, Washington, D. C., June 9-11, 1980.
6. A. M. Butkus and C. Y. Yang: "Electronic Structure of Cluster Modeling in PAN Fibers." Presented at the 2nd International Conference on Intercalation Compounds of Graphite, Provincetown, Massachusetts, May 19-23, 1980.
7. C. F. Hansen, T. E. Thompson, and C. Y. Yang: "Properties and Modeling of Carbon Fibers and Their Intercalation Compounds." Presented at the 2nd International Conference on Intercalation Compounds of Graphite, Provincetown, Massachusetts, May 19-23, 1980.
8. A. M. Butkus: "Cluster Model Studies of Oxygen Intercalated Graphite." Presented at the 2nd International Conference on Intercalation Compounds of Graphite, Provincetown, Massachusetts, May 19-23, 1980.
9. I. K. Varma, G. M. Fohlen, and J. A. Parker: "Structure-Property Relationship of Polyaromatic Bisimides." Presented at the American Chemical Society Meeting, San Francisco, California, August 28, 1980.
10. L. L. Fewell: "Release-Rate Calorimetry of Multilayered Materials for Aircraft Seats." Presented at the AIAA/ASME/ASCE/AHS 21st Structures, Structural Dynamics and Materials Conference, Seattle, Washington, May 12-14, 1980.
11. L. L. Fewell: "Total Heat Release Rate of Multilayered Materials and Construction of Fire Resistant Aircraft Passenger Seats." Presented at the Boeing Aircraft Company, Renton, Washington, May 14, 1980.

12. A. C. Poshkus: "Investigations on Phosphorylated Polyols as Aphrogenic Pyrostats." Presented at IUPAC Meeting on Phosphorus Chemistry, Halle, German Democratic Republic, September 17-21, 1979.
13. M. A. Golub: "Photosensitized Oxidation of Unsaturated Polymers." Gordon Conference on Polymers, Santa Barbara, California, January 15-19, 1979.
14. W. J. Gilwee and R. H. Fish: "A Small-Scale Test for Fiber Release from Carbon Composites." Presented at Conference on Advanced Composites--Special Topics, Southern California Society of Plastics Engineers, El Segundo, California, December 4-6, 1980.
15. M. T. Hsu, J. A. Parker, and A. H. Heimbuch: "Thermal Reactions of Stilbazole Derivatives." Presented at the 1979 Pacific Conference on Chemistry and Spectroscopy, Pasadena, California, October 1979.
16. R. L. Altman: "New Dry Chemicals for Extinguishing Fuel-leak Fires." Presented at the 1978 Pacific Conference on Chemistry and Spectroscopy San Francisco, California, September 27-29, 1978.
17. L. L. Fewell: FIREMEN Review by NASA Headquarters, Ames Research Center, Moffett Field, California, February 1978.
18. L. L. Fewell: Conference and Review of Firemen Program, Johnson Space Center, Houston, Texas, 1978.
19. L. L. Fewell: Fire Retardant Chemicals Association, San Francisco, California, October 31, 1978.
20. D. A. Kourtides: "Comparative Study of Thermoplastic and Thermoset Resins." Presented at the Third International Conference on Fire Safety, University of San Francisco, San Francisco, California, January 1978.
21. D. A. Kourtides: "Thermal Response of Composite Panels." Presented at the 36th Annual Technical Conference, Society of Plastics Engineers, Washington, D. C., April 1978.
22. D. A. Kourtides: "Assessment of Relative Flammability and Some Thermoplastic Materials." Presented at the 35th Annual Technical Conference, Society of Plastics Engineers, Montreal, Canada, April 1978.
23. D. A. Kourtides: "Overview of Fire Resistant Materials Program at Ames." Presented at the FIREMEN Meeting, Ames Research Center, Moffett Field, California, April 1978.
24. A. C. Ling, L. Mayer, and R. L. Altman: "Some Aspects of Dry Chemical Fire Control Agents: Laboratory Testing and Evaluation of Potential New Systems." Presented at the American Chemical Society National Meeting, Chicago, Illinois, September 1977.



25. N. R. Lerner: "Thermochemical Characterization of Polymers for Improved Fire Safety." Presented at the 2nd International Conference on Fire Safety, San Francisco, California, January 1977.
26. D. A. Kourtides: "Thermoplastic Polymers for Improved Fire Safety." Presented at the Conference at the Polymeric Materials and Their Use in Transportation, The Department of Transportation, Polytechnic Institute of New York, Brooklyn, New York, April 1977.
27. D. A. Kourtides: "Thermoset Polymers." Presented at the Regional Technical Conference, Society of Plastics Engineers, Hartford, Connecticut, October 1977.
28. D. A. Kourtides: "Flammability Characteristics of Some Thermoplastic Polymers." Presented at the 4th International Symposium on Flammability and Fire Retardants, Washington, D. C., May 1977.
29. R. W. Rosser: "Advanced Supersonic Technology Fuel Tank Sealants." Presented at the SCAR Conference, Langley Research Center, Hampton, Virginia, November 9-12, 1976.
30. R. L. Altman: "Progress Report on Chemistry Phase of Fire Suppression and Control Capability for Aircraft Survivability." Presented at the SFH Branch Conference, AF Aero Propulsion Laboratory, WPAFB, April 1976.
31. J. A. Parker: Conference on the Development of Fire-Resistant Aircraft Passenger Seats, Ames Research Center, Moffett Field, California, March 19, 1976.
32. D. A. Kourtides: "Fire Containment Tests of Aircraft Interior Panels." Presented at the 1st International Conference on Fire Safety, University of San Francisco, San Francisco, California, January 1976.
33. D. A. Kourtides: "A Composite System Approach to Aircraft Cabin Fire Safety." Presented at the International Seminar on Aircraft Rescue and Fire Fighting, National Fire Protection Association, Geneva, Switzerland, September 1976.
34. D. A. Kourtides: "Fire-Resistant Materials for Aircraft." Presented at the American Institute of Aeronautics and Astronautics Meeting, Atlanta, Georgia, January 1976.
35. D. A. Kourtides: "Materials Research for Aircraft Fire Safety." Presented at the Aircraft and Operating Problems Conference, Langley Research Center, Hampton, Virginia, October 1976.
36. W. J. Gilwee: "Fire Retardant Materials in Aviation." Presented at the Fourth Annual Plastics Symposium, California Polytechnic State University, May 29, 1975.
37. R. L. Altman: "Evaluation of Dry Chemical Fire Extinguishants." Presented at the IVth International Symposium on Combustion Processes, Czestochowa, Poland, September 16, 1975.

38. A. H. Heimbuch, J. A. Parker, A. Schindler, and H. G. Olf: "Low-Gravity Synthesis of Polymers with Controlled Molecular Configuration." Presented at the AIAA 10th Thermoplastics Conference, Denver, Colorado, May 1975.
39. J. A. Kourtides: "Fire Resistant Materials Technology." Bay Area Fire Protection Forum, Oakland, California, April 1975.
40. D. A. Kourtides: "Application of Fire Resistant Materials in Wide-Body Jets." Presented at the Symposium on Aircraft Interior Flammability, Boeing Aircraft Company, Renton, Washington, January 1975.

### Patents

1. D. A. Kourtides and J. A. Parker: "Process for the Manufacture of Low Density Bis-Maleimide-Carbon Microballoon Composites," U. S. Patent 4,193,829. March 18, 1980.
2. G. M. Fohlen and J. A. Parker: "Addition Polyimides Based on Bis(m-aminophenyl)methyl phosphine Oxide," In preparation.
3. R. W. Rosser: "Triazine Crosslinked Oxadiazole Polymers," NASA Case ARC 11253-1. 1980.
4. R. W. Rosser: "Fluoroether Triazines Containing Pendent Iodide Groups," NASA Cas ARC 11241-1. 1980.
5. R. W. Rosser: "Imidoyl Amidoximes: Intermediates for a Low Temperature Process in Preparation of 1,2,4-Oxadiazoles," NASA Case ARC 11267-1. 1980.
6. R. W. Rosser: "Preparation of Perfluorinated 1,2,4-Oxadiazoles," NASA Case ARC 11267-2. 1980.
7. D. A. Kourtides and J. A. Parker: "Low Density Bismaleimide Carbon Microballoon Composites," U. S. Patent 4,135,019. January 16, 1979.
8. R. W. Rosser: "Preparation of Heterocyclic-Perfluoroether Block Copolymers," U. S. Patent 4,145,524. March 20, 1979.
9. R. W. Rosser: "An Improved Process for Making Fluorinated Triazine Elastomers," NASA Case ARC 11248-1. 1979.
10. R. W. Rosser: "Amino-Substituted Triarylfluoroethanes," NASA Case ARC 11097-2. 1978.
11. R. W. Rosser: "Synthesis of Multifunctional Triarylfluoroethanes," NASA Case ARC 11097-1. 1978.
12. W. J. Gilwee and J. A. Parker: "Honeycomb-Laminate Composite Structure," U. S. Patent 4,061,812. December 6, 1977.
13. G. M. Fohlen, J. A. Parker, and P. M. Sawko: "Transparent Fire Resistant Polymeric Structures," U. S. Patent 3,928,708. December 23, 1975.
14. R. W. Rosser, R. H. Fish, and J. A. Parker: "Fiber Modified Polyurethane Foam for Ballistic Protection," U. S. Patent 3,916,060. October 28, 1975.

**CHEMICAL RESEARCH PROJECTS OFFICE**

**CHIEF: DR. J. A. PARKER**

**ASSISTANT CHIEF:  
D. A. Kourtides**

**M.E. GOMES  
SECRETARY**

**DR. A.H. HEIMBUCH  
TECHNICAL ASSISTANT**

**POLYMER RESEARCH PROGRAMS**

DR. G. M. FOHLEN  
C. F. HANSEN  
DR. N. R. LERNER  
DR. R. W. ROSSER

\*

DR. B. N. ACHAR  
DR. T. S. CHEN  
DR. C. H. CHENG  
J. HOLLOWAY  
DR. M. T. HSU  
  
M. L. ROSENBERG  
DR. I. K. VARMA

**AIRCRAFT OPERATING PROBLEMS & SAFETY**

DR. R. L. ALTMAN  
L. L. FEWELL  
W. J. GILWEE  
DR. M. A. GOLUB  
D. A. KOURTIDES

\*

R. D. CORMIA  
DR. A. C. LING  
D. D. O'BANION  
K. R. SHAW  
DR. D. VARMA  
R. MORIMOTO

**ENGINEERING TESTING**

DR. D. E. CAGLIOSTRO  
R. H. FISH  
E. J. FONTES  
J. A. MANSFIELD

\*

A. R. GRILLO  
M. GROSS  
DR. A. JAYARAJAN  
R. BALLARD  
B. N. ACHAR  
DR. D. MYRONUK  
W. WINSLOW  
A. BUTKUS

Non-Civil Service below  
line.